INLAND FISHERY

Instructional-cum-Practical Manual

Fish Breeding
and
Fish Seed Production

Volume II

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Project Coordinator

राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद्
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Foreword

The programme of vocationalization of higher secondary education has been accepted by the country as it holds forth great promise for linking education with the productivity and economic development of the country by providing education for better employability of the youth.

In view of the importance of the programme, the NCERT is making an all out effort to provide academic support to the implementing agencies in the States One of the major contributions of the NCERT is in the field of curriculum development and in the development of model instructional materials. The materials are developed through workshops in which experts, subject specialists, employers' representatives, curriculum framers and teachers of the vocational course are involved. These materials are then sent for try-out in schools and feedback is collected through questionnaires and through direct contact The materials are also sent to experts for comments before they are published.

The present manual on Fish Breeding and Fish Seed Production has been developed in the manner described above and is meant for the students studying Inland Fishery and allied vocations. It is being published for wider dissemination amongst students and teachers throughout the country. I hope that they will find the manual useful.

I am greatful to all those who have contributed to the development of this manual. I must acknowledge also the immense interest taken by Prof A.K. Mishra, Head, Department of Vocationalization of Education, in inspiring his colleagues in their endeavours to develop instructional materials Dr A.K. Dhote, Lecturer, functioned as the Project Coordinator for the development of this title in association with Dr. A.K. Sacheti, Reader. They have my appreciation and thanks for planning, designing and conducting the workshops, for technical editing and for seeing this manual through the Press.

Suggestions for improvement of this manual will be welcome.

P.L. MALHOTRA
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Preface

Ever since the introduction of vocationalization in our school system by several States in our country, the paucity of appropriate instructional materials has been felt as one of the major constraints in the implementation of the programme and a source of great hardship to pupils offering vocational studies at the higher secondary stage

The Department of Vocationalization of Education of the National Council of Educational Research and Training, New Delhi, has started a modest programme of developing instructional materials of diverse types to fill up this void in all major areas of vocational education. The task is too gigantic to be completed by any single agency but the model materials being developed by us might provide guidance and impetus to the authors and agencies desiring to contribute in this area These are based on the national guidelines developed by a working group of experts constituted by the NCERT

The present manual is on "Fish Breeding and Fish Seed Production" and is a common portion of the Inland Fishery/Fresh-water fish culture or related courses in a number of States It contains activities (practical exercises) to be performed by pupils, with simple steps to follow, precautions to be taken and data to be obtained and processed. Each activity is complete with brief theoretical information, objectives, behavioural outcome, evaluation, etc. It is hoped that the pupils will find them immensely useful.

The manual has been developed by a group of experts as authors in a workshop held at the Central Institute of Fisheries Education, Bombay, in March 1985. The names are mentioned elsewhere and their contributions are admirably acknowledged. Our thanks are also due to Dr. A.G. Kalawar, Fisheries Adviser to the Government of Maharashtra, Bombay, for the pains he took in verifying the authenticity of the contents of the manual Dr A.K. Sacheti, Reader and Dr. A K. Dhote, Lecturer, DVE deserve special thanks for editing and bringing the materials in the present form. The assistance of all in the C.I.F.E., Bombay, and Department of Vocationalization of Education, NCERT, is also greatfully acknowledged.

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About the Manual

Under the programme of Vocationlization of Education, about 20 different groups of vocational courses in the area of agriculture have been introduced by fifteen States and Union Territories so far. These courses have been running for the last six or seven years. From the very beginning, the Department of Vocationalization of Education in the NCERT has been working hand in hand with the State organizations concerned through various programmes organized for State officials, vocational teachers and others In fact, by now the Department has conducted on-the-spot studies of the vocational programmes in a large number of States to find out the merits and demerits of the programme and to suggest appropriate measures to resolve the problems in 'vocational agriculture education'. These programmes have revealed that there was a great dearth of suitable textual/instructional materials, the need for practical manuals, especially, was urgently felt. The development of instructional materials and the imparting of practical training become even more important when one considers the purpose for which the vocationalization of education programme has been launched. The main aim of the programme is to prepare the pupil for purposeful and gainful employment (wage-earning or self-employment).

Based on the guidelines formulated by the Working Group, Inland, Fishery/Fresh-water fish culture which is an important and popular vocational course in agriculture, was selected by the Department for the purpose of development of instructional materials in a phased manner To begin with, the development of instructional-cum-practical manuals has been taken up

The content of Inland Fishery and similar courses offered by the States and Union Territories under different titles was thoroughly analysed and it was felt that six manuals would be necessary to cater to the needs of the course. The present manual on Fish Breeding and Fish Seed Production is one of them. This manual is intended to help both teachers and pupils in the study of all aspects of natural as well as induced fish breeding under different conditions, as preparation for this vocation. While developing the manual, care was taken that it should include the maximum number of Activity Units (practical exercises) so that it can fulfil the requirements of the course prescribed by the States and Union Territories in the Inland Fishery as well as in other vocational courses.

These Activity Units are essential to develop the required vocational skills in the pupils. The manual explains in detail, the 'what', 'why' and 'how' of these Units.

In the manual, each Activity Unit has been dealt with under several sub-heads, viz., Instructional Objectives, Relevant Information, Precautions, Materials Required, Procedure, Observations, Expected Behavioural Outcomes and Questions.

Before commencing the actual work under any Activity Unit, the teacher should know what exactly the pupils have to learn and do, and should also assess whether they will be able to do that. Therefore, in the beginning, instructional objectives for the pupils should be framed in behavioural terms by the teacher.

In order to acquaint the pupils with the Activity Unit, the teacher should provide them with the required theoretical knowledge or information relevant to the activity This will help the pupils to properly understand the Activity Unit In other words, the 'what' and 'why' parts of the Activity Unit should be explained in advance by the teacher.

Once the pupils have understood the relevant theoretical instructions, the teacher should tell them about the precautions which are to be taken before and during the actual execution of the Activity Unit This will facilitate smooth working The 'how' part of the Activity should be explained by the teacher in the 'procedure' which pupils should follow while performing the Activity Unit.

Under the sub-head Observations, the teacher should tell the pupils what to observe and in view of that they should observe the situation, take readings, note down the temperature and similar other points under each Unit; these may vary from Unit to Unit. Wherever calculations are required to be done to obtain the results, this should also be indicated under this head or under a separate head.

At the end of the Activity, the pupil will have acquired certain abilities which should be closely related with the instructional objectives formulated for each Activity Unit. These abilities should be listed under the sub-head 'Expected Behavioural Outcome'. Evaluation should be based on the abilities acquired and it should be done by the teacher concerned.

For evaluating each aspect, the teacher will use a four-point scale, i.e A, B, C & D, and for each Activity Unit,. the Grade Point Average can be calculated as indicated below:

Suppose there are four aspects, each carrying equal weightage, and a pupil obtains 2A's, 1C and 1D and if A=4 point, B=3, C=2 and D=1 point; then, based on the grades, the pupil will get 11 points When the number of points obtained is divided by the total number of aspects examined, it will give the Grade Point Average, which, in this case, is 2.75. The tabular presentation is as under

Aspects	*Weightage*	*Grades Obtained*	*TOTAL POINTS (weightage × point-equivalent to grade obtained)*	*Grade Point Average*
1	1	A	1 × 4 = 4	$= \frac{11}{4} = 2.75$
2	1	C	1 × 2 = 2	
3	1	D	1 × 1 = 1	$= \frac{11}{4} = 2.75$
4	1	A	1 × 4 = 4	
			11	$= \frac{11}{4} = 2$ 75

At the end of the Activity Unit, some questions relevant to it are also given The pupils should write the appropriate answers after the completion of the Activity Unit and the teacher should examine these. If required, he should make suitable corrections and give suggestions However, answers to these questions will not be considered for the purpose of grading

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Introduction

India has vast potential resources in the inland fisheries sector in its tanks and ponds, reservoirs, brackish-water estuaries and lagoons, rivers and canals. According to the study carried out by Indian Institute of Management, Ahmedabad in 1982-83 on "Inland fish marketing in India" the inland resources comprise 7 53 lakh ha of ponds and tanks, 17 00 lakh ha. of reservoirs and 9 02 lakh ha. of brackish-water resources, besides about 29,000 kms of rivers and canals.

All these resources together contribute about 11.00 lakh tonnes of fish in the inland sector The bulk of this production is contributed only by the capture fisheries in rivers and reservoirs besides estuaries and brackish-water swamps and lagoons Any additional increase in inland fish production will not be forthcoming from caputre fisheries mainly because (i) the rivers, canals and other open waters have undergone drastic ecological changes due to heavy release of domestic and industrial waste in them, (ii) construction of barrages, dams and anicuts have restricted migration of fish and (iii) over exploitation of the resources to some extent due to lack of conservation These factors, and also the increasing diversion of river water for irrigation, are contributing towards the near stagnation in the production prospects of inland fish from these vast capture fisheries potential resources

Therefore, additional fish production from inland resources during the 7th Plan period is now planned by the exploitation of resources of 7 53 lakh ha. of tanks and ponds and 17.00 lakh ha. of reservoirs, by giving more emphasis on culture fisheries in tanks and ponds and culture-cum-capture in reservoirs. Along with this, conservation and regulation in capture fisheries is also being introduced so that the present level of production is sustained

However, for any additional production from culture fisheries, the main constraint is the non-availability of fish seed, the basic input for fish farming and for stocking in reservoirs

The study undertaken by the Indian Institute of Management, on "Inland Fish Marketing in India" indicates that about 10034 million fry will be the estimated requirement of fish seed in 1990-91 to meet the demand of culture fisheries in the country. Against this requirement, the present production is of about 5130 million fry, against the target of 2224 million fry in 1984-85 This spectacular achievement has been due mainly to the contribution by West Bengal of about 3200 million fry. West Bengal could achieve this all-time high fish seed production by (i) introduction of Chinese type circular eco-hatcheries in the private sector, (ii) financial assistance and technical guidance to the private sector in setting up hatcheries for fish seed production and (iii) dispersal of fish seed produced in West Bengal to other parts of the country for giving economic returns to the producer

The strategy adopted in fish seed production by the West Bengal Govt. is being adopted by other States also. The States shall be exploring all possible methods for fish seed production such as,

(i) Dry type of *bundh* breeding.
(ii) Wet type of *bundh* breeding.
(iii) Collection from natural resources wherever possible.
(iv) Common carp breeding.
(v) Induced breeding.
(vi) Introduction of Chinese type circular eco-hatcheries and other hatchery systems developed in the country.

The above mentioned methods of fish breeding can hardly yield the desired results if they are left to be implemented only by those who are, at present, engaged in the fishery profession. Till recently, fishery was considered not more than an occupation of certain communities. But now there is a dire need to vocationalize fishery, involving well-trained youth coming out from the school system. These methods will have to be applied by specially trained personnel, whose shortage is more than evident, particularly at the middle level operatives. Offering of Inland Fishery as a vocational course at +2 level is rightly expected to provide the country with vocationally trained youth having reasonably adequate expertise and skills in Inland Fishery.

The present manual on Fish Breeding and Fish Seed Production will be an invaluable aid to vocational students as well as to teachers of Inland Fishery, as it includes nearly all Activity Units (operations) that are essentially to be performed in the context of fish seed production. The Activity Units are designed in simple language, to apprise the students with the 'why' and 'how' of the entire operation. The training programme in Inland Fisheries, making use of the present volume, will certainly prepare vocationally competent hands who will be able to venture into the vast potential, hitherto not thoroughly exploited, field of Inland Fishery.

ACTIVITY UNIT: 1

Study of the Topography of a Spawn Bearing River

1.1 Instructional Objectives

The pupil should be able to:
know the importance of the study of the topography of a spawn bearing river;
identify the location of spawn in rivers;
understand the features of a spawn bearing river.

1.2 Relevant Information

Riverine Collection of Carp Seed

The seed of major carps – Catla, Rohu and Mrigal and some medium carps as well, are collected during the monsoon months, when the mature fish ascend the flooded rivers and breed in suitable ecological, meteorological and climatological conditions.

Why the study of the topography of a spawn bearing river?

Rivers constitute one of the sources for collection of spawn. Collection of spawn from natural waters like rivers is very relevant to our country as there are vast river stretches. The riverine fishery resources of India comprise five major river systems, namely, the Ganga, Brahmaputra and Indus river systems in the North, and the Peninsular East Coast and West Coast river system in the South.

Collection of spawn from rivers is an age-old practice. The study of the topography of a spawn bearing river is very essential for identifying possible spawn location sites in a river. Location of new spawn sites will have a far reaching effect on the fish seed production of the country. The basic requirement in fish farming is sufficient fish seed, so that more area can be brought under fish farming.

What are the main features of a spawn bearing river?

The river meanderings follow a serpentine course. There are bends and curves of various shapes in the river course – often a fast eroding bank on one side known as the erosion zone and a flat, gently sloping bank exactly opposite called the shadow zone. Both these banks are unsuitable for spawn collection. Better collection sites generally lie on the side of the sloping bank, but at a spot where the current just diverges, casting off spawn to the sides.

There may be tributaries, rivulets and *nallahs* adjoining rivers, which form important connecting links between the river and the breeding grounds. In the course of a river stretch, there are deeper zones and shallower areas to which fish migrate when conditions are favourable for breeding

1.3 Precautions

Carry out the observations on topography during the dry season

Choose as a site for fixing bamboo poles, one that does not have a rocky bottom

Choose a site which is not easily washed off by water currents

Collect samples of spawn at the appropriate time from the selected spawn collection site to get quality spawn

1.4 Materials Required

(i) Spawn bearing river to study the topography.

(ii) Paper and pencil to draw a rough sketch of the spawn bearing river.

(iii) Hand-net or a small dragnet which can be operated by two persons for taking samples of spawn.

(iv) Measuring cups.

(v) Small bottles

(vi) Formalin

1.5 Procedure

Visit the spawn bearing river in the dry season.

Observe topographical details like deeper zones, shallow areas, possible spawn collection sites, etc Collect data on rainfall, flood level, spawn sample, to know the quality of spawn and quantity per unit effort

Draw a rough sketch of the spawn bearing river after studying its topography.

Preserve three samples of spawn information separately for further examination

1.6 Observations

The pupil should observe and record the following

(a) Erosion zone

(b) Shallow zone

(c) Possible spawn collection sites

(d) Connecting links between the river and the breeding ground.

Observations made on (c) should be recorded as shown in the Table given on the opposite page

1.7 Expected Behavioural Outcome

The pupil will be able to

understand the basic features of a spawn bearing river,

locate new spawn collection centres in a river;

know the importance of the study of the topography of a spawn bearing river.

The teacher should evaluate the pupil for the above abilities

1.8 Questions

(i) How are spawn collection centres located in a river?

(ii) What are the precautions to be taken while selecting a spawn collection centre in a river?

(iii) Is there any limitation to riverine collection of spawn? If so why?

(iv) While studying the topography of a river, why is it necessary that the observations are made during the dry season?

(v) Spawn samples have to be collected from rivers at the appropriate time from selected sites Give reasons.

Table showing the observations made on possible spawn collection sites

Date of observations (1)	*Name of the River* (2)	*Area surveyed* (3)	*Site for collection of spawn* (4)	*Quantity of spawn collected* (5)

Period of collection No of Hrs. (6)	*Quantity of spawn collected per Man/Hrs* (7)	*Grade of collection ground: V Good/ Good/Fair/Not suitable* (8)	*Any other special observations (of major carp spawn)* (9)

embryonic fold	above anus Dorsal fin separating from the embryonic fold	fimbriated

TABLE II

Identification of Carp Spawn into Desirable and Undesirable Species

Length 5 0 to 5.5	
Yolk-sac accent, eyes pigmented, mouth formed, dorsal fin differentiated and with or without fin supports	Undesirable
Yolk-sac vestigial, disappearing, mouth formed, embryonic fin-fold continuous	Undesirable
Yolk-sac narrow anteriorly, embryonic fin-fold continuous, eyes pigmented	Undesirable
Yolk-sac wide anteriorly, embryonic fin-fold continuous, eyes pigmented, mouth formed	Desirable
Length 5.51 to to 6.5 mm	
Yolk-sac disappearing, rudimentary or absent, embryonic fin-fold, discontinuous, rudiments of dorsal fin with or without fin rays indicated, mouth formed, eyes pigmented	Undesirable
Yolk-sac wide or narrow anteriorly, embryonic fin-fold continuous, dorsal fin not indicated, mouth formed, eyes pigmented	Desirable
Length 6.51 to 7 5 mm	
Yolk absent, dorsal fin with rays well differentiated, rudiments of anal fin visible, embryonic fin-fold discontinuous	Undesirable
Yolk rudimentary or absent, dorsal fin indicated but without fin supports, embryonic fin-fold continuous, anal fin not indicated, mouth formed, eyes pigmented	Desirable

2.3 Precautions

Ensure the proper position of the net to avoid resistance of fast flowing water

Remove the spawn periodically to avoid overcrowding in the receptacle.

Ensure proper sieving of the collections to avoid predatory and competitor species.

Pull out the net from the water after 12 hours of the operation and dry it for at least 24 hours to prolong the life of the net

Condition the spawn before transportation to get rid of gut contents and to enable them to withstand the oxygen stress during transportation

Avoid overcrowded conditions during temporary storage to reduce mortality.

Choose a proper container for transportation of spawn keeping in view the quantity of spawn and duration of the transportation period

Midnapore type net 1/8" meshed is taken as the standard spawn collection net having the following dimensions.

Details of net parts	*Cm*
Length of net	320
Width at mouth	310
Height at mouth	60
Ring diameter	25
Height of *gamcha*	60
Length of *gamcha*	170
Width of *gamcha* at rear end	45

How are eggs collected from the breeding ground?

When the actual breeding ground has been located, the eggs are scooped out from shallower ground by means of rectangular pieces of mosquito netting of varying sizes.

What is conditioning of spawn before transportation?

Conditioning of spawn before transportation is necessary to enable it to withstand oxygen stress or limited oxygen conditions during transportation For the purposes of conditioning and temporary storage, pending their transfer to nurseries, the collected spawn is kept in *hapas* fixed in ponds, creeks or in the river close to the bank where the current is minimal or in a series of pits plastered with silt and filled with pond or river water. The size of the pits should preferably be 2m × 1m × ½m

What are the methods of packing and transportation of fish spawn?

Two methods of packing are in vogue

(i) Open system comprising open carriers, with or without artificial aeration/oxygenation/water circulation

(ii) Closed system having sealed air-tight carriers with oxygen

Transporting by means of traditional *hundies,* which is an earthen vessel, is an age-old method. Open metal containers are also sometimes used

Under the closed system of transport, sealed metal containers with oxygen, glass carboys, latex-rubber and plastic bags are used

How are lakhs of spawn counted in a short time?

It is almost impossible to count the lakhs of spawn collected, one by one, as it will take a very long time and during the counting the delicate spawn will get injured. In order to save time and to prevent injury to spawn, a practical method is adopted The tiny spawn collected is poured gently in a tea strainer up to the brim, and the spawn is counted If the strainer can hold two lakhs of spawn, this measure is used for counting Subsequently, only the number of strainerful of spawn is counted i.e five strainerful of spawn is taken as 10 lakhs Care will have to be taken to see that the spawn is of uniform size, as the bigger the spawn, the less is the number the strainer can hold

Why identification of spawn?

Identification and segregation of different species from a mixed collection of fish seed are of vital importance for selective stocking of ponds, in order to avoid wasteful culture of uneconomic species. Identification of species can be done on the basis of the following Tables·

TABLE I

Diagnostic Characteristic of the Spawn of Mrigal, Catla and Rohu

Life history Stages		*Species*	
	Cirrhinus mrigala	*Catla catla*	*Labeo rohita*
1	*2*	*3*	*4*
Hatching	Av size 4 20 mm. Narrow portion of yolk greater in length than the bulbous part. Yolk more or less club-shaped. 28 pre-anal and and 14 post anal myotomes in most of hatchings	Av size 4.68 mm Bulbous part of yolk and narrow part of equal length 26 pre-anal and 14 post-anal myotomes in most of the hatchlings.	Av size 3.78 mm. As in catla
24 hrs after hatching	Av size 6.21 mm Narrow end and yolk does not end in a point sharply	Av size 5 80 mm As in mrigal	Av size 5 49 mm Narrow end of yolk somewhat sharply ending in a point
36 hrs after hatching	Av size 6.70 mm. Anterior profile of yolk sac more or less straight	Av size 6 40 mm. Anterior profile of yolk convex	Av size 5 85 mm. as in catla
48 hrs after hatching	Av size 6.34 mm. Few black chromatophores in the caudal region. No reddish hue in the opercular area	Av. size 6 48 mm Reddish glow perceptible in the opercular area Dark somewhat triangular spot in caudal pendundle	Av size 6.20 mm A few faint black pigment spots below notochord in caudal region No reddish glow on the opercular margin
96 hrs after hatching	Av size 7.38 mm Black chromatophores on dorsal fin rudinent towards anterior portion Black chromotophores below the tip of notochord, confined to a semi-circular area. Red coloration seen in the abdominal region in Rohu and Catla absent Lips thin. Dorsal fin separating from the	Av size 7 56 mm. Semicircular mark, formed of black chromatophores, seen on ventral side of caudal towards end of notochord The arc of the semi-circle not well defined and the straight line of the semi-circle is mildly concaved Lip margins thick Reddish hue in abdominal area	Av size 7 57 mm Crescent shaped semicircular area below notochord formed of black chromatophores in rows A little above anus at the commencement of the ventral fin folding, in a majority of specimens, there is a red streak visible even with the unaided eye Lip margins gently

ACTIVITY UNIT: 2

Spawn Collection and Transportation from River

2.1 Instructional Objectives

The pupil should be able to .

understand, the importance of spawn collection and transportation from river;

distinguish between different methods of spawn collection;

identify the gear used for collection of spawn;

operate the gear used for spawn collection,

transport the spawn from the river to the desired destination.

2.2 Relevant Information

The fish fry trade has long been a well organized industry in India providing employment for hundreds of people. Considerable expertise has developed over the years in collection and handling of spawn and fry

Why collection and transportation of spawn?

The spawn of the Indian major carps is collected from flooded rivers during the monsoon months by means of shooting nets. The collection of spawn is highly localized However, farming of fish can be carried out almost anywhere in the most diverse habitats and climatic conditions — in ponds, lakes, reservoirs, etc This clearly indicates that there is a need to transport fish spawn or fry from its collection centre to the place of fish farming

What is a shooting net?

A shooting net is the gear used for collection of spawn. It is a funnel-shaped net of finely woven netting which is operated in shallow margins of a flooded river with the mouth of the net facing the current. At the cod end of the net, there is a ring of split bamboo or cane and to this is attached a receptacle called *gamcha.*

What is a "gamcha"?

It is a receptacle attached to the shooting net during the operation. It is a rectangular, open piece of cloth. Sometimes, it also has the shape of a monk's hood The spawn moving alongwith the marginal current, collects in the *gamcha* from where it is periodically scooped, seived through a non-metallic strainer to remove larger organisms and debris and stored in *hapas* or in specially prepared mud pits.

Dimensions of a standard spawn collection net

Shake the *hundies* periodically

out this trial netting by means of a boat

Scoop out the collection from the cod end of the net, one after the other, in quick succession

Remove the floating debris

Transfer the contents to some convenient container half filled with river water

Pass the collection through a round meshed mosquito netting sieve to a trough of muslin cloth Keep the lower third of the trough immersed in water.

Sieve through an 1/8” meshed netting before transferring to the mosquito netting sieve if the collection is laden with non-floating debris and unwanted organisms

Measure the spawn in a suitable measuring cup.

Condition the spawn depending upon the size and quality of spawn

Transport the spawn in suitable containers

For transportation in oxygenated plastic bags, follow the procedure given below:

Take plastic bag of 45 × 65 cms.

Place it in a cardboard or tin container.

Fill it to about half the capacity with 6-7 litres of water

Transfer the conditioned spawn to the plastic bag

Drive air out of the bag by squeezing its empty upper portion

Connect the bag with the oxygen cylinder and fill it completely with oxygen.

Tie the mouth of the bag firmly.

Despatch the bag to its destination.

Ensure that the water and oxygen do not leak from containers.

Ensure low temperature of water in the containers

2.4 Materials Required

(i) Shooting net.
(ii) Bamboo poles.
(iii) Boat
(iv) Container half filled with river water.
(v) Spawn
(vi) Round meshed mosquito netting sieve
(vii) Trough of muslin cloth.
(viii) 1/8” meshed netting
(ix) Measuring cups.
(x) *Hapas*
(xi) *Hundies*/any other container.

2.5 Procedure

Fix bamboo firmly in the selected spot

Slip the loops of one end of the net mouth over it.

Stretch the other end firmly across the path of the current and fix it in place with the help of another bamboo pole

Leave the net adrift in water so that it positions itself along the direction of the current.

Stretch the net by pulling the cod end ring It is fixed in position with the help of two more bamboo poles

Tie the anterior end of the *gamcha* around the ring while fixing the posterior end with the help of another pair of bamboo poles

Operate a number of trial nets simultaneously at a number of suitable spots in order to ascertain the spot of maximum availability of spawn Carry

2.6 Observations

The pupil should observe and record the following:

(a) Quantity of spawn collected on the muslin cloth after sieving.

(b) Oxygen content in the container in which the spawn is transported

Observations should be recorded in the Table given below;

2.7 Expected Behaviour Outcome

The pupil will be able to:

understand the importance of spawn collection and transportation from rivers;

operate spawn collection nets,

identify spawn of desirable and undesirable species, distinguish between the diagnostic characteristics of the spawn of Catla, Rohu and Mrigal;

Name of the river *(1)*	*Area of collection* *(2)*	*Site of collection* *(3)*	*Date of collection* *(4)*	*Period of collection No. of hours* *(5)*

Quantity of spawn collected Man/hrs *(6)*	*Quality of spawn Catla% Rohu% Mrigal%* *(7)*	*Duration of conditioning (in hrs)* *(8)*	*Type of packing* *(9)*

Quantity of spawn per container packed *(10)*	*Quanity of spawn survival per container at the destination* *(11)*	*% of survival of spawn per container* *(12)*	*Special remarks, if any* *(13)*

understand the various mothods of packing and transportation of fish seed,

select the appropriate method for transportation,

collect and transport fish spawn,

count lakhs of spawn in a short time

The teacher should evaluate the pupil for the above abilities.

2.8 Questions

(i) What are the factors which determine the period of conditioning of spawn before transportation?

(ii) What is the difference between the closed system and open system of packing and transportation of fish seed?

(iii) What is the role of conditioning in improving the quality of fish seed transported?

(iv) Why is segregation of spawn important?

(v) What are the measures to be taken to reduce the mortality of fish seed during transportation?

(vi) How can the shooting net be maintained for a longer period?

(vii) How can lakhs of spawn be counted in a short time?

(viii) What is the importance of spawn collection from rivers?

(ix) What is the importance of transportation of spawn from rivers?

ACTIVITY UNIT: 3

Study of the Topography of a Typical Wet Bundh

3.1 Instructional Objectives

The pupil should be able to.

understand the importance of the study of the topography of a typical wet *bundh* in relation to breeding of fish,

understand the basic topography of a wet *bundh,*

appreciate the importance of the catchment area, inundated breeding ground;

follow the operational details in producing the seed of major carps

3.2 Relevant Information

Production of quality fish seed is very important since it is a basic required input for fish culture in tanks and ponds and for stocking in reservoirs for culture-cum-capture fisheries. There are three methods of fish seed production, viz collection of spawn from rivers, collection of eggs from wet and dry *bundhs* and induced breeding or hypophysation. The seed produced from a wet *bundh* may sometimes be a mixture of both desirable and undesirable species but with proper indentification of the spawning ground of major carps, the eggs of major carps can be easily collected from a wet *bundh*

What is a wet bundh?

Perennial *bundh*/large tanks or minor irrigation reservoirs where breeding takes place are called wet *bundhs* The *bundhs* are filled with run-off water from extensive catchment areas during monsoon rains and create large shallow marginal areas which serve as spawning grounds for the fish present in the *bundh*

Main features of a wet bundh

The main features of a wet *bundh* are as follows·

Lateritic or sandy soil allowing fast runoff of the rain water

sloping depression in an undulating terrain

Embankment to hold water throughout the year

Extensive catchment area to fill the *bundh*

Overflow weir

In summer, generally a greater part of these *bundhs* dries up while the central part always contains water

When to collect the eggs?

Eggs should not be collected immediately after spawning as they get damaged About six hours after spawning, the shell covering the egg gets hard, which is called 'water hardening' This stage lasts for about six hours and is the most suitable time for collection and transportation After another six hours, the shell becomes brittle and gets damaged Hence, collection of eggs at a suitable stage is most important

3.3 Precautions

Confirm that the wet *bundh* holds water throughout the year

Ensure that the wet *bundh* has a stock of major carps

Collect eggs at the appropriate time from selected egg collection sites to get quality eggs

3.4 Materials Required

(i) Wet *bundh* to study the topography

(ii) Paper and pencil to draw a rough sketch of a wet *bundh*

3.5 Procedure

Observe the topographical details of the wet *bundh* in the dry season

Study the catchment area and the slope of the terrain in detail

Find out the possibilities of further increasing the catchment area

Collect data on rainfall, flood level, etc

Draw a rough sketch of the wet *bundh* after making a thorough study of the topographical features

3.6 Observations

The pupil should observe and record the following

Catchment area.

Location of overflow weir

Possible sites of egg collection

3.7 Expected Behavioural Outcome

The pupil will be able to

appreciate the significance of the study of the topography of wet *bundhs* in increasing the production of fish seed,

take an independent decision regarding egg collection centres from given topography details of a wet *bundh*

The teacher should evaluate the pupil for the above abilities

3.8 Questions

(i) Is it possible to indentify egg collection centres in a wet *bundh* without studying its topography? Substantiate your answer

(ii) How does the study of the topography of a wet *bundh* help in the development of fisheries?

(iii) In what way does a wet *bundh* differ from a dry one?

ACTIVITY UNIT: 4

Breeding of Major Carps in Wet Bundh

4.1 Instructional Objectives

The pupil should be able to·

appreciate the importance of breeding of major carps in a wet *bundh;*

understand the topography of the portions of the ·*bundh;* where breeding occurs,

collect the fertilized eggs from the breeding ground;

rear the fertilized eggs to the hatching stage,

transport the hatchings to nurseries.

4.2 Relevant Information

Why fish seed production?

Fish seed of desirable quality is a basic input for fish farming in tanks and ponds and for culture-cum-capture fisheries in medium and major reservoirs There are at least three different systems of fish seed production of major carps Spawn (early stage of fish seed) can be obtained from (a) riverine source (b) *bundh* (dry or wet) and (c) induced breeding (hypophysation) The seed produced from dry *bundhs* and by induced breeding is of pure quality because in these systems controlled breeding of desired species of fish can be undertaken

In rivers and wet *bundhs,* fish of all varieties breed together during monsoon rains when the banks of rivers and *bundhs* get inundated with flood waters. The spawn collected from these sources, therefore, is of mixed variety, with no practical method available to segregate them. Therefore, to obtain fish seed of desirable quality, adequate care has to be taken in egg collection from a wet *bundh* There is a wide gap between fish seed production and fish seed demand Therefore, all possible sources of fish seed production require adequate study and utilization.

Why fish breeding in a wet bundh?

Major carps breed annually in rivers when they are flooded with muddy rain water during the monsoons. Similar riverine conditions are created in a wet *bundh* when silt-laden flood water enters them during heavy monsoon rains Therefore, due to the creation of riverine conditions in wet *bundhs,* the major carps breed in shallow ground inundated with monsoon rains.

What is water hardening?

Eggs should not be collected immediately after spawning as they get damaged. About six hours after spawning, the eggs shell covering the egg becomes hard, which is called water hardening. This stage lasts for about six hours, and is the most suitable time for handling and transportation After another six hours, the shell becomes brittle and gets damaged while handling. Hence, the collection of eggs at a suitable time is most important

How to distinguish between fertilized and unfertilized eggs?

Fertilized eggs are transparent with the embryo clearly visible in the centre of the egg Unfertilized eggs are opaque

Importance of fish seed collection from wet bundh

If due care is taken to locate the breeding ground of major carps in a wet *bundh*, pure and quality fish seed can be produced for fish farming in tanks and ponds However, besides locating the breeding ground, arrangements have to be made for collection of eggs, proper handling while collecting and arranging their hatching.

If the operation is carried out carefully, quality fish seed can be produced from a wet *bundh* also

4.3 Precautions

Examine the fish catch regularly to determine the availability of major carps in the bundh.

Survey the catchment area to locate the possible areas of fish migration for breeding.

Survey the *nala* joining the *bundh* to find out if fish will migrate to it for breeding due to its favourable topography

Make adequate arrangements to collect eggs by *gamcha* from the bank of the *bundh*.

Make adequate arrangements to hatch the eggs collected.

4.4 Materials Required

(i) A wet *bundh* with major carp stock
(ii) Shallow margin area for spawning and adequate catchment area to flood the *bundh*.
(iii) Egg collection nets (triangular with fine mesh or spawn collection shooting net)
(iv) *Hapas* (outer and inner) for egg hatching in *bundh* or in nearby fish farm
(v) Earthen pots *(hundies)*/metallic containers/buckets for egg and spawn transportation
(vi) Plastic bags and containers for long distance transportation
(vii) oxygen cylinder for spawn transportation

4.5 Procedure

Observe the on-rush of rain water and filling of *bundh*

Observe carefully the movement of fish for breeding during heavy rains in the beginning of the monsoon.

Observe large scale movement of fish for breeding (Splashing and coupling will follow. In about one to one and a half hours, breeding will commence)

Observe breeding, locate the spot; fish may breed either in a *nala* or on shallow, inundated banks.

Allow breeding to be completed. Breeding may last for one to two hours.

Allow fish to leave breeding ground and eggs to settle down and get water hardened

Collect the fertilized eggs with a *gamcha* — a spawn collection net if breeding takes place in a *nala*

Transport the eggs to hatching *hapas* fixed in *bundh* or in fish farm in the vicinity

4.6 Obsevations

The pupil should observe and record the following

(A)

(a) Time of breeding/location of breeding ground/depth of breeding ground

(b) Extent of flooding of reservoir/time taken in flooding (maximum, minimum level)

(c) The fish observed during splashing/breeding

(d) Any other related observation.

(B)

Quantity of egg collected (in lakhs)	*% of fertilized eggs*	*Quantity of eggs transferred (in lakhs)*	*Quantity of hatching obtained (in lakhs)*	*% of survival*

Note: the mode of transportation of eggs, method adopted for hatching (in wet *bundh* or at fish farm) may be also mentioned

(C). Inspect the spent fish if caught or found dead due to some reason

4.7 Expected Behavioural Outcome

The pupil will be able to·

appreciate the principle and importance of breeding of fish in a wet *bundh;*

. locate the breeding ground of major carps in a wet *bundh,*

collect the eggs of major carps,

produce fish seed from wet *bundh.*

The teacher should evaluate the pupil for the above abilities

4.8 Questions

(i) What are the main feature of a wet *bundh?*

(ii) How are the eggs collected from a wet *bundh?*

(iii) What are the merits and demerits of a wet *bundh* and a dry *bundh?*

(iv) What is water hardening of eggs? Why is this important?

(v) How do you distinguish between fertilized and unfertilized eggs?

ACTIVITY UNIT: 5

Study of Topography of a Typical Dry Bundh

5.1 Instructional Objectives

The pupil should be able to

know the importance of the study of the topography of a typical dry *bundh;*

know about the soil, importance of catchment;

Select an area with similar features to create a new *bundh,*

understand the basic features of a dry *bundh,*

5.2 Relevant Information

Why dry bundh breeding of major carps?

The fish seed of desirable quality is a basic input for fish farming in tanks and ponds and culture-cum-capture fisheries in reservoirs Traditionally, fish seed is collected during the monsoon from flooded rivers where major carps breed annually along with other fish such as the minor carps and cat fish. Due to this reason, fish seed collected from rivers is of a mixed quality. There is no practical method available by which the seed can be segregated into different species to meet the fish farmers' demand for fish seed for stocking in tanks, ponds, and in medium and major irrigation reservoirs. Therefore, by dry *bundh* breeding of major carps, pure quality of fish seed can be produced and sold to fish farmers.

What is a dry bundh?

The basic features of a dry *bundh* are the following·

(i) Shallow sloping depression in an undulating terrain.
(ii) Lateritic or sandy soil allowing fast runoff of rain water
(iii) Large runoff area from catchment, having forest or uncultivated fields
(iv) Embankment to hold water of the first and subsequent rains
(v) Shallow adjoining flooded breeding area
(vi) An overflow screened weir

How to locate a suitable area?

After understanding the basic requirements of major carps' breeding and the topography of a typical dry *bundh,* it is not difficult to select a suitable area for the location of a new dry *bundh* An extensive survey of the forest and uncultivated area should be done to find a shallow sloping depression in undulating terrain The catchment area should be assessed and, if possible, the possibilities of increasing it by cutting a trench or making small embankments should be studied The area thus selected should be on sandy or lateritic soil, allowing fast runoff of rain water

The area selected for locating a dry *bundh* must be in the close proximity of a tank or a small irrigation reservoir to facilitate transportation and availability of brood stock to carry out breeding operations

How to proceed in establishing a dry bundh?

The area selected for developing as a dry *bundh* should be surveyed with the help of an overseer to draw a contour map of the area. The contour map of the area will indicate the maximum depression available which can be encircled with an embankment to form a *bundh* The earth work needed to make the embankment can be worked out, which will give an estimate of labour requirements to excavate the earth as well as the expenditure involved in the construction. The excavation of earth will further increase the depth of the depression, allowing more water holding capacity to the *bundh*. To minimize the cost of construction, the following points should be borne in mind

(i) The contour map should be carefully prepared
(ii) The deepest portion of the depression should be selected
(iii) The lift and lead of the earth should be minimum
(iv) The earth dumped on the embankment should be properly levelled by a hand as foot roller or a sheep roller with sprinkling of water
(v) The construction of the *bundh* should be completed before the monsoon.

Construction of waste weir

The construction of a waste weir is an essential part of the dry *bundh* A waste weir protects the main embankment of a dry *bundh* and also allows an escape route to extra rain flood water. The waste weir is located at a spot which allows maximum filling of the *bundh* for the operation of the *bundh* and also discharges extra or additional water

The waste weir is a *pucca* masonry structure made of bricks and cement so that it is not washed off by the current of water passing through it It is also provided with a wire mesh so that brood fish stocked in the *bundh* do not escape with the current of water passing through the waste weir when excess rains overflood the *bundh*.

The waste weir constructed in minor and major irrigation reservoirs can be examined to understand its principle, design, location and the material used for its construction

5.3 Precautions

Ensure that a suitable site is available for the purpose

Collect data on rainfall, flood level, etc

Ensure the demand of fish seed in the locality

5.4 Materials Required

(i) Contour map of the area
(ii) Data on rainfall in the area
(iii) Record of the highest flood level in the area in the last 10 years
(iv) Plastic bag for soil sample collection
(v) Spade for collection of soil sample
(vi) Paper and pencil to draw a rough sketch of the dry bundh.

5.5 Procedure

Study the catchment area

Explore the possibility of increasing the catchment area by diversion
Survey the slope of the terrain, soil of the terrian to ensure rapid flow of water.
Identify the site of the embankment and waste weir.
Select topography requiring minimum construction of embankment and a small waste weir
Survey the discharge of water from waste weir to *nala* or drainage canal
Collect the surface soil sample to confirm the texture of the soil

5.6 Observations

The pupil should observe and record the following;

(a) Terrain and soil conditions
(b) Catchment area ensuring the rain water to the *bundh*
(c) Suitability of the site for *bundh* and waste weir construction
(d) Suitability of the possible breeding ground level, surface for easy egg collection.
(e) Measurement of the area (catchment, *bundh*, embankment and waste weir)
(f) Draw a rough sketch of the site and indicate the shallow portion of the terrain, the position of the waste weir and the embankment
Work out the earth excavation needed for embankment construction
Work out the details and cost of waste weir construction
Work out the cost of hatching pit construction, if possible.

5.7 Expected Behaviour Outcome

The pupil will be able to
realize the importance of the study of the topography of a typical dry *bundh*,
appreciate the requirement of a dry *bundh;*
select the location for a dry *bundh* construction;
draw a sketch of a dry *bundh*.
The teacher should evaluate the pupil for the above abilities

5.8 Questions

(i) What are the main characterstics in the topography of a dry *bundh*

(ii) What is the importance of a screened waste weir in a dry *bundh*?

(iii) What is the importance of a dry *bundh* in fish seed production?

(iv) What are the merits and demerits of dry *bundh* breeding?

(v) What is the importance of the study of the topography of a typical dry *bundh*?

ACTIVITY UNIT: 6

Breeding of Major Carps in Dry Bundh

6.1 Instructional Objectives

The pupil should be able to:

appreciate the importance of breeding of major carps in a dry bundh;

collect the fertilized eggs from the breeding ground;

rear the fertilized eggs to hatchling stage;

transport the hatchlings to nurseries.

6.2 Relevant Information

Why fish seed production in dry bundhs?

The fish seed of desirable quality is the basic input for fish farming in tanks and ponds and for culture-cum-capture fisheries in reservoirs. There are at least three different systems of fish seed production. Spawn (early stage of fish seed) can be obtained from (a) riverine source (b) *bundhs* (wet or dry) (c) induced breeding (hypophysation). The seed produced from dry *bundhs* and by induced breeding is of pure quality because in these systems controlled breeding of desired species of fish can be undertaken. In rivers, and wet *bundhs,* fish of all varieties bread together during the monsoon rains when the tanks get inundated with flood waters. The spawn collected from this source, therefore, is of mixed variety, with no practical methods available to segregate them.

Therefore, by undertaking fish breeding in dry *bundhs*, quality fish seed can be produced. According to an estimate, the fish seed requirements for stocking in ponds and existing reservoirs will be around 334 crore standard fingerlings in 1990-91 against the present planned production and supply of about 174 crore standard fingerlings. Hence, there is a wide gap between the fish seed production and the demand of fish seed for stocking All possible resources of fish seed production, therefore, require attention.

Why fish breeding in a dry bundh?

Major carps breed annually in adjoining shallow areas of rivers, reservoirs and wet *bundhs* when they are flooded with muddy, fresh rain water during the monsoons Similar conditions are created in a dry *bundh* also on small scale, inducing fish to breed in dry *bundhs.* Traditionally, fish breeding in dry *bundhs* was practised in Midnapore and Bankura districts of West Bengal but now it is practised also in Madhya Pradesh, Rajasthan, Haryana, Uttar Pradesh and in other parts of the country.

Importance of fish seed from dry bundhs

The fish seed produced from dry *bundhs* is of pure quality, and there is a high demand for it.

The fish seed production from dry *bundhs* is easy and can be practised in most parts of the country The equipment needed for such fish breeding is less expensive and can be operated by semi-skilled workers in the field

6.3 Precautions

Ensure that the dry *bundh* is properly laid out with adequate catchment area, strong and firm *bundh,* overflow/waste weir, screen on waste weir to prevent escape of fish.

Ensure the availability of healthy brood fish, fully matured and gravied by checking the brood stock before breeding operations.

Select a rainy, cloudy day for the operation.

Carry out the operation in the afternoon to ensure cool temperature for egg collection and hatching.

Make arrangements for lights (petromax) to guarantee the egg collection even during the night.

6.4 Materials Required

(i) A well laid out dry *bundh.*
(ii) Brood stock of all species of major carps in a tank in the vicinity.
(iii) Arrangments for brood fish transportation.
(iv) Egg collection nets (triangular with fine mesh) or cloth *gamcha.*
(v) *Hapas* (outer and inner) for egg hatching in *bundh.*
(vi) Earthern pits wherever possible with water flow arrangements for egg hatching
(vii) Plastic bags and containers for long distance spawn/hatchling transportation
(viii) Earthen pots *(hundies*/metallic containers/buckets) for hatchling transportation
(ix) Oxygen cylinders for hatchling packing
(x) Bamboo/other equipment for fixing *hapas* in the *bundhs.*

6.5 Procedure

Allow the first rain water to accumulate in the deper portion of the *bundh*

Introduce fully gravied females and oozing males.

Introduce two males for every female. See that the weight of the females and males introduced is maintained at a 1:1 ratio.

Observe breeding during the next spell of rain when the *bundh* is filled with muddy rain water, inundating the breeding ground portion of the *bundh*

Observe the movement of fish for breeding Splashing and coupling will follow In about one to one and half hour after movement of the fish, the breeding will be observed.

Allow breeding to be completed. Breeding may last for one to two hours.

Allow eggs to settle and become water hardened.

Collect the fertilized eggs and transfer them to hatching *hapas* and hatching pits.

Remove the spent brood stock To identify the spent fish cut the fin portions or give some marking.

Discharge the excess water by siphoning

Prepare the *bundh* for the next breeding

6.6 Observations

(a) The pupil should observe and record the following.

(b) Inspect the spent males. Observe if milt is still oozing. If so, males can be re-used

(c) Inspect the females. Feel the belly to find out total or partial breeding.

(d) Collect an egg sample and find out percentage of fertilization.

(e) Observe the development of the embryo in a control sample after every two hours.

Species	*Average wt of females*	*Number of females*	*Number of males introduced*	*Total eggs ★ expected on full breeding*
Catla Rohu Mrigal				

★ On an average, 1 to 2 lakhs per Kg wt., 2 to 3 lakhs per Kg. wt., and 1 to 2 lakh per Kg wt eggs are likely to be released on full breeding by Catla, Rohu and Mrigal fish species respectively.

6.7 Expected Behavioural Outcome

The pupil will be able to:
acquire confidence to undertake breeding of fish in a dry *bundh;*
collect the eggs from the dry *bundh;*
hatch the eggs in the dry *bundh,*
produce fish seed economically from the dry *bundh,*
appreciate the importance of breeding of major carps in dry *bundhs.*
The teacher should evaluate the pupil for the above abilities.

6.8 Questions

(i) What are the characteristics of a dry *bundh?*

(ii) What is the importance of breed fish in a dry *bundh?*

(iii) What is the importance of timely egg collection?

(iv) What are the merits and demerits of *bundh* breeding?

(v) What is water hardening of eggs? Why is this important?

(vi) How do you distinguish between fertilized and unfertilized eggs?

ACTIVITY UNIT: 7

Breeding of Common Carps

7.1 Instructional Objectives

The pupil should be able to:

appreciate the importance of breeding of the common carp;

understand about the spawning behaviour and season;

identify the adhesive eggs,

know about the substratum required for egg attachment (aquatic weeds and other materials);

select healthy brooders and handle them carefully;

fix breeding *hapas* with the substratum.

7.2 Relevant Information

Importance of common carp breeding for seed production for fish culture

The common carp is an exotic species, highly compatible with major carps. In contrast to major carps, it is easy to breed this species naturally in confined water Therefore, fish seed of the common carp can be easily produced for fish culture along with major carps in tanks and ponds. It can also be stocked in small reservoirs. The culture of the common carp has become popular all over the country. It has a protracted breeding season, breeding almost throughout the year unlike the Indian major carp which generally breeds only during the rainy season.

Spawning behaviour and spawning season

The common carp breeds twice in a year, the breeding season extending from January to the middle of March and from July to August. Generally, it starts spawning during the morning hours. It lays adhesive eggs. It breeds in the temperature range of 20 to 30°C.

Fecundity

A female weighing 1 kg. gives 1.5 to 2 lakh eggs.

Maintenance and selection of brooders

Three months before breeding, the males and females are separated in two ponds (2000 Kg/ha). Natural food is supplemented with artificial feed (rice bran and oil cake, 1:1 at the rate of 2 to 3% of the body weight) The mature male shows roughness on the dorsal surface of the pectoral fin and freely oozing milt when the abdomen is slightly pressed. The mature female has a bulging abdomen and a reddish vent.

Breeding

The breeding of the common carp can be practised in the following manner:

By introducing the substratum in the spawning pond and releasing the breeders

By putting the substratum and the breeders in the breeding *hapa.*

By putting the substratum and the breeders in cement cisterns

By collecting the substratum with eggs and transferring it to the hatching *hapa*

7.3 Precautions

Feed selected brood fish with supplementary feed

Sun dry the pond before stocking (to get rid of aquatic vegetation and predatory insects/fish).

Avoid entry of predatory organisms in the pond

Wash the substratum used for the attachment of eggs

Do not use excess aquatic weeds for the substratum for egg attachment

Cover breeding *hapa* to avoid jumping of brooders.

Remove spent fish immediately after spawning

7.4 Materials Required

(i) Spawning pond/cement cisterns
(ii) Healthy brooders
(iii) Breeding *hapa*
(iv) Hatching *hapa*
(v) Bamboo poles
(vi) Substratum for egg attachment (weeds, plastic filaments, *kakabans,* etc)

7.5 Procedure

A. Breeding in spawning ponds

Keep male and female breeders separately for 3 months for successful spawning.

Select a small spawning pond (20 to 30 m^2 area).

Dry it completely.

Allow the water to enter the spawning pond through a screen

Introduce the substratum (Hydrilla, Eichornia, *Kakaban,* etc) after thorough washing.

Maintain the depth (½ to 1 m) of the water

Introduce the breeders (1 kg/10 m square of spawning pond)

Keep 2 males for one female.

Observe the breeding (likely in the morning).

Remove the spent fishes

Keep 2 *kakabans* (if used) of 100 × 60 cms size (female) and water at about ½ metre level

Collect the substratum with eggs after 1-2 hours and transfer to hatching *hapa*

B Breeding in hapas

Take a *hapa* (size 2-3 m long, 1-2 m broad and 1 m deep).

Fix it with bamboo poles.

Introduce fully ripe breeders (2:1 male. female).

Introduce the substratum for attachment of eggs on the basis of the body weight of females:

1-2 Kg. females – 2 Kg. of weeds in 2 m. long *hapa.*

3-4 Kg. females – 3 Kg of weeds in 3 m long *hapa.*

4-5 Kg females – 4 Kg. of weeds in 4 m. long *hapa.*

Cover the *hapa* with a cloth
Observe the breeding (likely in the morning)
Remove spent fish to stock ponds.
After complete spawning (1-2 hours), collect substratum with eggs
Transfer to hatching *hapa*

C Breeding in cement cisterns

Clean the cistern and fill with water (about 1/2 m depth)
Select healthy brooders and introduce in cisterns (number depending on the size)
Introduce substratum
Maintain flow of water in cement cisterns
Observe breeding within 6 to 12 hours
Remove the spawners to stock ponds
Collect the substratum with eggs (after 1-2 hours of spawning) and transfer to hatching *hapa*

D Hatching of eggs

Take a hatching *hapa* (size 2m × 1m × 1m) made of thin cloth
Fix it in the pond
Put fertilized eggs in *hapa* (do not disturb them for 3 days).
Take out the weeds (substratum) after complete hatching and collect hatchlings for rearing

7.6 Observations

The pupil should observe and record the following
(a) Weight of brooders = (male and female)
(b) Temperature of water (in spawning pond/cistern)
(c) Total number of eggs laid
(d) Percentage of fertilization
(e) Time of hatching
(f) Percentage of hatching
(g) Time required for the absorbtion of yolk-sac

Table for recording the observations

S.No. (1)	*Wt of female released for spawning* (2)	*Loss in wt of female after spawning* (3)	*% loss in weight* (4)	*Total No. of eggs likely* (5)

% fertilization (6)	*Time of hatching* (7)	*Total No. of fertilized eggs kept for hatching* (8)	*Total No of spawn obtained* (9)	*% of survival* (10)	*In case of high mortality identify the reason* (11)

7.7 Expected Behavioural Outcome

The pupil will be able to:
understand common carp breeding, fish seed production;
know about the various methods of common carp breeding,
reason out the causes of unsuccessful spawning;
handle the brood fish, eggs and hatchings carefully

The teacher should evaluate the pupil for the above abilities

7.8 Questions

(i) What is the importance of common carp breeding in seed production for fish culture?

(ii) How does the breeding of common carps differ from that of major carps?

(iii) What are the different methods adopted for breeding of the common carp?

(iv) Why is it necessary to use the stratum for common carp breeding?

ACTIVITY UNIT: 8

Identification of Brooder

8.1 Instructional Objectives

The pupil should be able to:

identify mature males and females of different species for breeding;

distinguish between the external characteristics of mature males and females;

select the proper brooders for carrying out seed production.

8.2 Relevant Information

What is a brood fish?

Mature male and female fish that will breed if injected with harmones or put in *bundh* type of tanks for breeding, are called brood fish

Why is it necessary to identify brood fish?

Fish seed is the basic need for culture of fish. But cultivable Indian major carps do not breed in captivity They are artificially bred in *bundhs* and by injection of harmones. Only mature male and female fish, that will breed if injected or put into *bundhs,* are used for this purpose Identification of mature males and females is, therefore, necessary. This requires experience and skill. The dose of the injection depends upon the stage of maturity of the brooder.

Where are brood fish found?

Brood fish are found in rivers, reservoirs and other water bodies where a stock of fish above two years of age is available. For breeding in *bundhs* and by induced breeding, such fish are specially reared in small tanks After winter, the healthy fish above two years of age are separated and kept in small ponds and fed with supplementary feed In the case of other Indian major carps except Catla, fish weighing 2-3 Kg , Catla weighing 1.5-5 Kg , and common carps weighing around 1 Kg. are better brooders. These are easy to handle and give better response in induced breeding

How to identify male and female brooders?

In the case of females, the belly of the mature fish is round and soft. The softer the belly, the better is the condition of the female. When a fully mature female is held, belly up, its belly bulges out at both sides and the mid-ventral ridge disappears. The vent is pink in colour, extrovert, and covered with a papilla The inner side of the pectoral fin of the female is very smooth and soft

In case of males, the inner side of the pectoral fin is rough (like sandpaper) Sometimes, even the body is rough The vent of the ripe male fish is introvert, white and if pressed, oozes thin white (milk-like) milt freely

8.3 Precautions

Avoid injury to the brooders while netting and handling

If injured, treat the fish immediately and release it

Any brooder, if gilled, should not be forced out of the net as it may cause injury. The net may be cut to release the fish

Only those females with a round belly and pink vent should be selected

Males that ooze (milk-like) milt freely, should be selected

8.4 Materials Required

(i) Hand-net — two
(ii) Scissors — one pair
(iii) Tub—50 litre capacity—one.
(iv) Foam cushion — one
(v) Acriflavin powder/potassium permanganate.
(vi) Brood fish

8.5 Procedure

Take brooder out in a handnet.

Hold it, the belly up, the back resting on the cushion

Examine the colour of the vent, its shape and softness.

Feel the belly towards the vent to observe the degree of softness

Feel the inner side of the pectoral fin with one finger from the tip of the fin towards the body, of both female and male

In the case of a male, examine to see if it oozes thin white (milk-like) milt freely

8.6 Observations

The pupil should examine the brooders following the procedure given below in tabular form and select the proper males and females on the basis of the following characteristics

8.7 Expected Behavioural Outcome

The pupil will be able to:

distinguish between males and females;

identify the proper type of mature brooders,

select proper brooders for breeding.

The teacher should evaluate the pupil for the above abilities.

Observation	*Males*	*Females*
When held belly up	A ridge appears in the mid-ventral region of the belly. Sides do not bulge out.	Sides bulge No mid-ventral ridge Belly round and bulging
Inner side of the pectoral fin	Rough, feeling like sand-paper (sometimes body also rough).	Smooth and slippery to touch
Vent	White in colour, introvert, pit-like appearance, white (milk-like) fluid oozes freely.	Pink in colour, extrovert covered with papilla A few loose ova may appear if slight pressure is applied.

Observations made while identifying brooders should be recorded in the following table:

Specimen No	*When held belly up (observation)*	*Innerside of the pectoral fin (observation)*	*Vent*	*Identification Male/Female*	*Condition of maturity*
1					
2					
3					

8.8 Questions

Tick the correct answer

(i) The vent of a mature male is — extrovert/introvert/pink in colour/white in colour

(ii) When a female is held in a belly up position — Sides of the belly bulge out/sides of the belly do not bulge out/shows a mid-ventral ridge/does not show a mid-ventral ridge

(iii) The pectoral fin of a male is — Rough outside/rough inside/slippery outside/slippery inside

(iv) A female oozes — thin (milk-like) liquid/ova with pressure/without pressure

(v) The weight of fish preferred for induced breeding is — More than 5 Kg./less than 5 Kg./above 1 Kg./below 1 Kg.

ACTIVITY UNIT: 9

Raising of Brooder Stock

9.1 Instructional Objectives

The pupil should be able to.

understand the importance of raising brood stock,

maintain a good stock of brood fish,

learn about manuring of the brood stock pond and artificial feeding of the brood stock,

gain self confidence to raise a health brood stock for successful breeding operations

9.2 Relevant Information

Major carp breeding

The major carps of India breed only once a year during the monsoon period After the winter is over, almost all major carps above 1½ years of age commence gonad development. Before the monsoon, they reach the peak of maturity. For raising brood stock for undertaking induced breeding and for *bundh* breeding, healthy fish of 1½ to 2 years of age weighing 1-3 Kg in the case of the Rohu, Mrigal, Calbasu and 1.5-3 Kg. in the case of the Catla and around 1 Kg in the case of the common carp, are netted out and kept separately in smaller, shallow brood stock ponds They are stocked at a lower rate in the ponds for giving them better facilities to develop gonads. The rate of stocking is generally 2500-3000 Kg/ha. These brood stock fish are regularly checked for their condition, and fed with artificial feed. Artificial feed at the rate of 2-3% of their body weight is given There are various types of feed, however, for Indian major carps — rice bran and mustard oilcake at the rate of 1·1 by weight, is generally used as artificial feed Initially, all brooders are kept together One month before the monsoon, male and female fish can be segregated and maintained separately till they are used for breeding

Care on the following aspects is necessary for the maintenance of brooders.

Observation on physico-chemical conditions of the pond. The ideal conditions of a brood pond maintenance are given below:

(a) Temperature — 20-30°C
(b) pH — 6 2 – 6.7.
(c) Dissolved oxygen — 8-10 ppm.
(d) Good production of plankton.
(e) General hygienic conditions of the pond
(f) Change of water, if possible, to accelerate growth.
(g) Regular feeding to supplement the natural food
(h) Monthly checking of the fish to observe maturity stage.

Why are brood fish maintained separately?

Special care is taken for the maintenance of brood fish so that they remain healthy and their gonadas (male and female sex organs) develop properly Success of breeding is entirely dependent on a good brood stock.

Manuring of brood pond

The manuring of the brood pond should be done with raw cow dung, in small doses, at an approximate rate of 250 Kg. of cow dung/ha water area every fortnight In case of excess phytoplankton bloom, manuring may be stopped If food (zooplankton) is low, the rate of manuring may be increased Zooplankton is the main food of the fish Manuring produces zooplankton in water.

How is the food of fish in the pond assessed?

Zooplankton, forms the food of carp brooders Early in the morning, water samples from different places of a tank are collected and sieved through a plankton net. If 1 cc of zooplankton accumulates in the receptacle of the net after sieving of 50 litres of pond water, the pond has moderate food material and 3 cc of zooplankton in 50 litres of water indicate that the pond has very good food for the stocked fishes. In this condition, artificial feeding can be reduced

Feed preparation and feeding

Rice bran and mustard oilcake are soaked in water overnight These are mixed in 1:1 proportion. Some binding material, viz. starch or straw, etc , is added to the feed and these are converted into round feed balls. These feed balls are kept in trays under water at different fixed places in the pond, twice daily If all the feed is eaten, feeding may be increased to thrice daily. If some feed remains unutilized in the trays, feeding may be reduced

Symptoms of a diseased fish

The following characteristics indicate that a fish is diseased.

(i) sluggish movement
(ii) sunken eyes
(iii) loose scales
(iv) head proportionately bigger
(v) red or white patches on the body
(vi) bare skin
(vii) torn or frayed fins

9.3 Precautions

Remove the diseased fish immediately
Wherever possible replenish pond water monthly
Manure the pond after drawing fresh water in it and not before draining water out
Stop manuring if phytoplankton bloom appears in the water
Avoid excess feeding

9.4 Materials Required

(i) Dragnet — 1
(ii) Hand-net — 2 Nos.
(iii) Enamel tray — 6 Nos.
(iv) pH metre with accessories — 1
(v) Thermometer for water temperature — 1
(vi) Plankton net with tube — 1.
(vii) Mug — 1 (one litre capacity)
(viii) Manure — raw cow dung at the rate of 5-10 thousand Kg/ha/yr
(ix) Rice bran at the rate of 1 5% of the body wt. of the stock

(x) Mustard oilcake at the rate of 1 5% of the body wt. of the stock
(xi) Earthen vats — 2 Nos.
(xii) Potassium permanganate/Acriflavin powder.
(xiii) Water pump — 1.

9.5 Procedure

Apply lime if necessary (If water is too acidic, pH below 6).
Apply raw cow dung (in small doses) at weekly intervals
Assess plankton on alternate days in the morning
Feed twice daily at selected spots in trays
Maintain water depth by addition of water.
Examine pH, DO and temperature daily, early in the morning
Net out the fish by a dragnet, once every month
Examine them for disease, infection, growth, etc.
In case of disease/injury, treat them in a separate pond.
Remove the fish which are not growing for some reason.

9.6 Observations

The pupil should observe the following:

(a) Growth rate of fish
(b) Adequate availability of plankton in the pond.
(c) Disease/distress symptoms in fish
(d) Utilization of artificial feed by fish
(e) Optimal physico-chemical conditions of the water

9.7 Calculations

The pupil should calculate the following:

(a) Take weight of 10 randomly selected fishes at the time of stocking of the pond. Find out the average weight of individual fish by dividing the total weight of 10 fishes by 10 Say it is 'x'
(b) At the end of one month, take the weight of randomly selected 10 fishes. Find out the average weight of individual fish by dividing the total weight of 10 fishes by 10. Say it is 'y'.
(c) Substract 'x' from 'y' Say it is 'a'
(d) Divide 'a' by the number of days of rearing (in this case it is 30).
(e) This gives the rate of growth of fish/day. Say 'b'
(f) Greater value of 'b' indicates better maintenance.

9.8 Expected Behavioural Outcome

The pupil will be able to

Record the observations in the following Table

Date of observation (1)	*Average weight of fish from Pond A (2)*	*Average weight of fish after 30 days from the same pond (3)*	*Rate of growth of fish/day (4)*	*Grade of growth Good/ Fair/ Satisfactory (5)*

maintain a stock of brood fish;
maintain healthy conditions in a pond,
understand about the food and feeding habits of fish for good growth,
assess the dynamics of growth of brood fish

The teacher should evaluate the pupil for the above abilities.

9.9 Questions

(i) Why are brood fish maintained separately?

(ii) How do you assess availability of adequate quantity of food in a brood pond?

(iii) How do you distinguish a diseased fish from a healthy one?

(iv) How is feed given to brood fish and what is the rate of feeding?

(v) How is a brood pond manured and why?

(vi) What is the importance of raising brood stock?

ACTIVITY UNIT: 10

Collection of Pituitary Gland and Preservation

10.1 Instructional Objectives

The pupil should be able to

appreciate the importance of collection of the pituitary gland and its preservation;

collect pituitary glands from donor fish;

preserve pituitary glands for future use.

10.2 Relevant Information

Why the pituitary glands have to be collected?

Quality fish seed is the basic input for fish culture in tanks and ponds for stocking in reservoirs for culture-cum-capture fisheries. The major carps breed annually in flooded rivers and wet *bundh* type of tanks as do all other species of fish Therefore, spawn from these natural sources is of a mixed nature, moreover, the supply of seed from natural sources does not satisfy the demand. Induced breeding of major carp is one method by which quality fish seed can be produced in large quantities. For induced breeding, mature male and female fish are injected with fish pituitary gland extract during the monsoon when both the weather and the condition of the fish are favourable Injected male and female fish are kept together in a closed *hapa* for breeding The pituitary gland contains gonad stimulating hormones which stimulate the development of gonads and ultimately makes the fish breed The pituitary gland is necessary to prepare the pituitary extract which induces fish to breed

When is the pituitary gland collected?

The development of the gonad of fish commences after the winter season and reaches its peak before the monsoon period when fish breed in nature. Pituitary glands remain highly potent during pre-monsoon months (April-May) During this period glands are collected from freshly killed/well preserved mature (above 1½ years of age) carp fish Glands collected immediately after spawning are also potent

How is the gland collected?

The cover of the skull of the fish is cut open by a hacksaw. A chisel and hammer can also be used Below the skull bone, the brain remains covered with grey matter The grey matter is slowly removed with the help of a spatula and cotton, to expose the brain. The brain is thereafter gently lifted up with forceps Below the brain, in the centre of the brain box, the pituitary gland, a round, white gland, separated from all brain matter is situated in a small groove, well secured beneath a transparent membrane. The membrane is removed gently by forceps Now the cleared white gland becomes prominently visible. The gland is attached at the base with a stalk which cannot be seen without removing the gland. With the help of a bent needle or an arrow-headed needle, the gland is detached from the stalk The gland is then, picked up with forceps and put in a container (cavity block) along with other freshly collected glands, in absolute alcohol

How is the gland preserved?

Three-four hours after collection, all freshly collected glands are washed with absolute alcohol and transferred to fresh alcohol. After 24 hours, the glands are again washed with absolute alcohol and kept in fresh alcohol. Thus, alcohol is changed 2-3 times. After about a week or more, the glands are removed from the common container, 2-3 at a time, on to a piece of blotting/filter paper, dried under a fan, weighed accurately in mg in a sensitive balance and individual glands are then kept separately in small vials, in absolute alcohol Absolute alcohol dehydrates the glands, dissolves fats and preserves the glands for a long time. The weight of each gland is noted and attached to the vial or is written on the cork of the vial, or only a serial number is allotted to the vial and against that serial number, the actual weight is noted in a register. All vials are kept in refrigerator or in a dark, cool place in a desiccator

10.3 Precautions

Use clean equipment for both collection and preservation of glands

Collect glands, from mature, freshly killed or well preserved fish only.

Do not use water for collection or preservation

Dry vials before putting alcohol for storing glands

Keep glands under sufficient alcohol

Check preserved glands from time to time, add alcohol if necessary

Before weighing, dry glands in the air/over blotting paper.

Avoid strong sunlight and heat.

Do not pierce the gland

Do not use very sharp forceps or needle

Carefully handle a Catla donor as its gland may come along with the brain mass when it is lifted.

10.4 Materials Required

(i) Absolute alcohol
(ii) Hacksaw or hammer and chisel
(iii) Cotton.
(iv) Spatula — 1.
(v) Forceps, fine-tipped — 1.
(vi) Forceps, flat-tipped — 1.
(vii) Bent needle — 1
(viii) Arrow-head needle — 1.
(ix) Cavity block — 1
(x) Chemical/Electric balance — 1.
(xi) Small vials for each gland
(xii) Pencil — 1.
(xiii) Paper/register

10.5 Procedure

Open the skull with a hacksaw/hammer and chisel

Remove blood and grey matter gently with a spatula and cotton to expose the brain

Lift up the brain slowly with forceps.

Lift carefully the transparent covering membrane of the gland.

Free the gland with bent/arrow-head needle and keep in the cavity block containing alcohol.
After 3-4 hours, wash the glands in alcohol
Take out gland with forceps and keep in the watch glass.
Keep the glands again in alcohol
Change alcohol every 24 hours, twice or more
After a week, take out 2-3 glands at a time, on a blotting paper. Dry in the air, weigh individually and put in separate vials in alcohol.
Label each vial with serial numbers and note total weight of individual glands in a register against their serial numbers
Put the vials in a refrigerator/dark, cool place in desiccator.

10.6 Observations

The pupil should observe how·

(a) Glands become hard in alcohol.
(b) Alcohol gets turbid when fresh glands are stored

Record the observations in a register as follows·

Date of collection (1)	*Species and weight of donor fish (2)*	*Sr No of the vial in which it is preserved (3)*	*Wt of the Pituitary gland in mg. (4)*

10.7 Expected Behavioural Outcome

The pupil will acquire the ability to·
collect the pituitary glands from donor carp fish,
preserve pituitary glands for future use.

The teacher should evaluate the pupil for the above abilities.

10.8 Questions

(i) Why is the pituitary gland collected?

(ii) How is the gland collected?

(iii) How is the pituitary gland preserved?

(iv) Why is absolute alcohol used for storing glands?

(v) Which is the right time for collection of the pituitary gland? Indicate the months.

(vi) Make a list of the equipment required for collection of glands.

(vii) Fill in the blanks

(a) Pituitary glands contain harmone

(b) Pituitary glands are stored in for future use

(viii) Tick the correct answer

(a) Glands should be collected from
Small/big fish
mature/immature fish

(b) Monsoon/premonsoon/winter season is the best time for collection of glands

ACTIVITY UNIT: 11

Preparation and Administration of Pituitary Hormone Injection

11.1 Instructional Objectives

The pupil should be able to·

prepare the pituitary hormone injection,

inject the required strength of pituitary injection to brooder for inducement of breeding,

understand the importance of breeding of carps by administration of pituitary hormone injection

11.2 Relevant Information

Why is induced breeding necessary?

Fish seed is the basic requirement for development of fish culture Cultivable Indian major carps do not breed in captivity They breed annually in rivers and *bundh* type of tanks during monsoon rains Riverine collection is quite often a mixture of desirable and undesirable varieties of carps and other minor carps and cat fish. Although live seed can be produced through *bundh* breeding, this method is confined at present only to some areas of West Bengal and Madhya Pradesh. For fish culture in remote areas, fish seed has to be transported there from a long distance, which sometimes causes heavy mortality This is a very cumbersome and costly process. To avoid these difficulties, fish are bred by the induced breeding technique all over the country to produce quality fish seed to stock in ponds or reservoirs for capture and culture fisheries

What is induced breeding of major carps?

Induced breeding of major carps is a process by which the gravied fish are bred by giving them pituitary hormone injections

What are the doses for males and females?

Female fish are generally given two injections at four hourly intervals Extract of 3-6 mg of pituitary gland/Kg body weight is administered to the female fish as an initial dose After 4 hours, the female is examined If it develops satisfactorily (indicated by a more bulging and softer abdomen and a reddish vent), a lower second dose is administered If development is not satisfactory, a higher dose is given Generally, as a second dose, extract of 4 to 8 mg of pituitary gland/Kg body weight is given Females are always given higher doses than males. Males are given only one injection while the females are given two injections, and then the males and females are kept together. Males are generally given extract of 2-4 mg pituitary gland/Kg body weight.

What is the male, female ratio?

Generally, two males having the same weight as the famale are put together in a single *hapa*. This makes one set (2.1 by weight).

How is the dose prepared?

The selection of the dose depends on the condition of the brooder and the experience of the person handling induced breeding. In general, 0.1 cc of distilled water is used for 1 mg of pituitary gland. The extract may be diluted according to convenience, keeping in mind that more than 1 cc of extract is generally not given to one fish. Before giving the injection, the total weight of each fish to be injected is noted. The total quantity of gland required is calculated. The gland is mascerated in tissue homogenizer in the required volume of distilled water. This solution of pituitary gland and distilled water is centrifuged. The supernatant clear solution is injected to the fish.

Where is the injection given?

The injection is given at the caudal peduncle region of the fish in between posterior end of the dorsal fin and base of caudal fin, above the lateral line, avoiding the lateral line.

How is the injection given?

While giving the injection, the fish is taken out of the *hapa* with a hand-net and kept on a foam cushion. One person gently presses the head of the fish against the cushion, covering the eye with his palm. Another presses the base of the fin against the foam cushion with his left hand and holds the syringe in his right hand. With the help of the needle, a scale is lifted. The needle is inserted at about 15° angle, then lifted to 45° angle to pierce the muscle and the extract is injected by gently pushing the piston of the syringe. Then the fishes are introduced in the breeding *hapa*. After 4-6 hours, they start splashing and release eggs.

11.3 Precaution

Wash and clean all equipment.
Keep pituitary extract in a refrigerator in closed tubes.
Use forceps for handling glands.
Dry glands gently over blotting/filter paper, before mascerating.
While centrifuging solution, balance the other centrifuge tube with equal volume of water.
Never inject on lateral line.
Avoid air bubble in the syringe.
Take more than one gland to prepare the required strength of solution.
Prepare a little more solution than the exact requirement.

11.4 Materials Required

(i) Pre-weighed preserved pituitary glands
(ii) Forceps — 1
(iii) Blotting/filter paper
(iv) Watch glass — 2.
(v) Tissue homogenizer — 2 sets.
(vi) Distilled water — 1 bottle
(vii) Wash bottle
(viii) Injection needle (no 21 and no 19 2 each
(ix) Injection syringe — 2 sets

(x) Acriflavin/potassium permanganate
(xi) Hand-net — 2
(xii) Foam cushion — 1
(xiii) Hand centrifuge 1 set.
(xiv) Centrifuge tube (glass) — 2 sets
(xv) Wooden stool — 1

11.5 Procedure

A For preparation of dose.

Note the weight of each brooder (male and female) separately.
Calculate total weight of pituitary glands required to prepare injections
Fix centrifuge firmly on the stool.
Select a few glands weighing slightly more than the total weight of glands required
Gently press glands between blotting/filter paper
Dry glands under a fan for one minute.
Fix needle firmly in the syringe.
Draw calculated volume of water for the glands taken.
Mascerate glands thoroughly with a little water from the syringe.
Wash the postle of the mascerator with the rest of the water in the syringe in the homogenizer tube.
Pour solution in the centrifuge tube.
Balance the other tube with equal volume of water.
Centrifuge for 3 minutes, beginning slowly and finishing slowly
Slowly decant supernatant clear liquid in a tube

B. For injection

Take out fish with a hand-net
Draw required volume of extract in the syringe
Expel air bubble, if any, in the syringe (by holding the syringe straight upwards and pushing the piston slowly)
Inject as described in Relevant Information (11 2)
Release the brooder in *hapa*

11.6 Observations

Observe the following:

(a) Glands become hard and dark in colour if kept in the air for long
(b) After centrifuging the suspended material in the extract settles at the bottom leaving supernatant liquid clear.
(c) The condition of the female develops after the first injection (belly bulges more and becomes round and softer, weight increases, vent becomes reddish).

11.7 Calculations

Exercise. Calculate the doses for two sets of brooders comprising one female Mrigal weighing 1 5 Kg. and one female Rohu weighing 2.0 Kg The Mrigal female should be injected at the rate of 3.0 and 5.0 mg of glands per Kg body weight for the first and second dose respectively The Rohu female should be administered with 3.5 and 6.0 mg of glands per Kg. body weight for the first and second dose respectively All males will be injected with one injection at the rate of 2 0 mg gland/Kg. body weight, Table given on page 40.

For the first dose 11.5 mg of glands are required This may be prepared with 12-13 mg of glands in 1 2-1.3 cc of distilled water. The Mrigal female will be given 0 45 cc and the Rohu female, 0.7 cc of the extract The excess 0 05-0.15 cc of the extract may be discarded or stored in a refrigerator for future use

Species	*Sex*	*Wt. in Kg.*	*1st dose*		*2nd dose*	
			rate mg/kg.	*Total wt. of gland (mg)*	*rate mg/Kg.*	*Total wt. of gland (mg)*
Mrigal	Female	1.5	3.0	4.5	5.0	7.5
Mrigal	Male-1	1.0	—	—	2.0	2.0
	Male-2	1.5	—	—	2.0	3.0
Rohu	Female	2.0	3.5	7.0	6.0	12.0
	Male-1	2.0	—	—	2.0	4.0
	Male-2	1.5	—	—	2.0	3.0
Total Gland	1st dose			11.5 mg.	2nd dose	31.5 mg.

For the second dose 31.5 mg glands are required. 32 mg of glands may be prepared in 1.6 cc of water. After injecting 0.6 cc of extract to the Rohu female, the rest of 1 cc extract may be diluted by adding 1 cc of distilled water, (in this case if 32 mg of gland was dissolved in 3.2 cc of water at the beginning and the Rohu female had to be given more than 1 cc (1.2 cc) of extract which is not generally given) to make it 2 cc. Then the Mrigal female and four males may be injected with 0.75, 2.0, 3.0, 4.0 and 3.0 cc of water totalling 1.95 cc. The rest of 0.05 cc of extract may be discarded or kept preserved in a refrigerator. A little more gland is taken as a precautionary measure.

11.8 Expected Behavioural Outcome

The pupil acquires the ability to:
appreciate the importance of the preparation and administration of pituitary hormone injections in induced breeding of major carps;
prepare the pituitary extract injection;
inject the brooder for breeding.

The teacher should evaluate the pupil for the above abilities.

11.9 Questions

(i) Describe the method of preparation of pituitary gland extract.

(ii) Discuss the use of the pituitary gland in induced breeding.

(iii) Tick the correct answer:
(a) Males are injected – once/twice at an interval of 4 hours/8 hours.
(b) Males are generally injected – lower/higher dose than females.
(c) The second dose given to the female should be lower/higher.

(iv) Fill in the blanks:
(a) A pituitary injection is given at the .... region . .... the lateral line.
(b) Pituitary gland extract is injected in female brooders at the rate of . . ... mg/kg. of body weight

(v) Can the pituitary gland of any fish be used for induced breeding of major carps? If not, explain why

(vi) How long can pituitary glands be preserved for effective use in fish breeding?

(vii) Why is the ratio 2 males : 1 female recommended to be observed in breeding *hapas?*

ACTIVITY UNIT: 12

Induced Breeding of Major Carps

12.1 Instructional Objectives

The pupil should be able to:

collect the pituitary glands of fish and preserve them for use,

prepare doses of pituitary extract and administer them to brooders,

identify mature male and female brooders,

fix a *hapa* in the correct manner;

learn about the breeding behaviour of fishes,

examine the percentage of fertilization of eggs;

hatch the eggs,

rear spawn for 48 hours.

12.2 Relevant Information

For identification of brooders, raising of brood stock, collection of pituitary glands and preservation and preparation and administration of pituitary hormone injections please refer to Activity Units 8-11.

Fish Breeding Hapa

A breeding *hapa* is a box-like cloth enclosure made of longcloth, generally of the size of 3 × 1 × 1 with provision to close its top after releasing the brooders. The upper flap is attached to one side and the other sides are either tied or buttoned. For additional strength, the sides and also the margins of the *hapa* are stitched with strong cloth tapes A *hapa* has a provision to tie it with six bamboo poles

According to convenience, a *hapa* is fixed in canal water or in a pond or sometimes, even in a cemented cistern The four bottom corners of the *hapa* are tied to 4 poles. The upper corners of the *hapa* are then tied to the respective poles. One-third of the *hapa* should remain above water level. The bottom of the *hapa* should also not touch the ground

Breeding Operation

The second injection to the female and first injection to the male are generally given late in the evening. Then the males and females are released into the breeding *hapa*

After the brooders are released in the *hapa,* they should not be disturbed, After about 6 hours, splashing will commence for breeding. This generally continues for about one hour. After the movement and splashing has stopped, the *hapa* may be examined for eggs by taking out some water in a mug from the bottom of the *hapa* If eggs are observed in the *hapa* they may be allowed to get water hardened for about an hour To remove spent fish from the *hapa*, the bottom corners at the open mouth end are opened and the fish are driven gently to this corner and scooped out by a hand-net .

If the fish have not bred, their condition is examined and sometimes, if the weather conditions are good, a second injection to the males and a third to the females is administered, at a higher dose than the previous injections and they are kept in the *hapa* for another 6 hours If the brooders are not in good condition, they are transferred back to the stock pond.

If the fish have bred, the males are examined to determine whether they still have sufficient milt In case the milt comes out, the male can be re-used In the case of the female, its belly is examined to observe the extent of egg laying

Examination of eggs

After the eggs are water hardened, a sample of the eggs is taken in a beaker to estimate volume. Though the size and colour of eggs vary from species to species, bad eggs of all species have common characteristics — the nucleus of the egg disintegrates within one hour and the eggs become opaque The fertilized good eggs are transparent with a clearly visible nucleus at the centre. These have better lustre

The number of good eggs and the number of bad eggs are estimated from the sample and the percentage of fertilization is calculated. The total number of eggs laid is calculated by measuring the total volume of eggs while transferring the eggs to the hatching *hapa*/hatchery.

Hatching of eggs

For transferring eggs to the hatching *hapa*, one side of the breeding *hapa* is loosened and lifted All the eggs come to one side of the *hapa* From the *hapa*, the eggs are taken out with a mug of known volume and transferred to buckets The eggs in the buckets are then transferred to the hatching *hapa* or hatchery

Hatching *hapas* are a set of two *hapas* The smaller one is called the "inner *hapa*" and is made of round mosquito net The inner *hapa* is fixed in the "outer *hapa*", made of muslin cloth Organdy and nylon cloth can also be used in making the outer *hapa* Unlike the breeding *hapa*, the hatching *hapa* has no cover The hatching *hapa* is fixed in a canal or pond. It can also be fixed in a cistern or plastic pool. Instead of fixing with poles, the hatching *hapa* may also be kept floating with suitable floats and instruments. Generally wooden frames are used in floating *hapas*

The eggs are released in the inner *hapa* at the rate of 75,000 to 1.5 lakhs If the eggs are kept for hatching in a hatchery, these are put according to the capacity of the hatchery jar or bucket. In these buckets there is an inner egg container with round meshed netting as in the CIFE Model-D-80/81 The eggs are released in the inner container provided with water circulation arrangements.

The eggs develop in the inner hatching *hapa*/hatchery jar/buckets. At optimum temperature (24-30°C) the eggs hatch after 16 hours At cool temperatures hatching is delayed. After all the eggs have hatched the inner *hapa* is lifted. Egg shells get removed with inner *hapa* itself Hatchlings pass over to the outer *hapa* They are kept in the outer *hapa* for about 48 hours and during this period, hatchlings depend on their yolk-sacs. When the yolk-sac is completely absorbed they are removed gently from the outer *hapa* to the nursery for feeding

12.3 Precautions

As mentioned in Activity Units Nos. 8, 9, 10 & 11. Further precautions are:

Do not disturb brooders for 6 hours after the second injection to females.

Avoid unnecessary handling of brooders, eggs and spawn.

Close *hapa* properly after releasing brooder into it, otherwise the fish may jump out.

12.4 Materials Required

As mentioned in the Activity Units Nos 8,9,10 & 11 and:

- (i) Breeding *hapa* with six poles and ropes.
- (ii) Hatching *hapa* (set) with poles/frame and float.
- (iii) Carp egg hatching unit (hatchery)
- (iv) Beaker — 1 (200 cc cap).
- (v) Mug — 1 (1 litre cap).
- (vi) Wide mouth dropper — 1
- (vii) Small enamel tray — 1.
- (viii) Hand-net (big mesh) — 1.
- (ix) Enamel/plastic bucket — 2 nos.
- (x) Spawn measuring cups (assorted) — 1 set.
- (xi) Needle (for counting egg/spawn)

12.5 Procedure

As in Activity Units 8,9,10,11 and:

Fix breeding *hapa* properly.

Release injected brooders (one female/two males) into *hapa*

Examine breeding *hapa* after 6 hours.

Collect sample of eggs after 1-2 hours.

Count the total number of good and bad eggs

Calculate percentage of fertilization.

Fix hatching *hapas*

Take measured volume of eggs and transfer it into the hatching *hapa*/hatchery jars

Lift the inner *hapa*/inner egg container of the hatchery *hapa*/hatchery jar when all fertilized eggs have hatched.

After 48 hours, gather hatchlings at one place in the hatching *hapa*.

Scoop out hatchlings with known measuring cup and keep in bucket.

Transfer hatchlings from bucket to the prepared nursery.

Keep some good eggs in a tray and observe development of the embryos every hour

12.6 Observations

As given in Activity Unit 8,9,10 & 11 and:

- (a) Condition of spent fish
- (b) Difference in fertilized and unfertilized eggs.
- (c) Development of embryo inside the egg till hatching.
- (d) Development of hatchling up to formation of mouth.

12.7 Calculations

As in the Activity Units referred to above (8-11) and take sample of eggs from the breeding *hapa* and·

- (a) Count the number of total eggs — say 5000 in one beaker.
- (b) Count the number of bad eggs — say 1000
- (c) Find out the number of good eggs. — say 5000-1000=4000.
- (d) Find out percentage of fertilization (good eggs) by the formula $\frac{c}{a} \times 100 =$ % age of good eggs = 80%

Find out volume of eggs (by counting the total number of beakersful of eggs and mutliplying by the volume of the beaker) Suppose there are twenty beakers of eggs and the volume of one beaker is 250 cc

Therefore, the total volume of eggs = 250 × 20 = 5000 c.c. or 5 litres.

Number of total eggs in one beaker = a

(e) Number of total eggs laid = a × 20 = 1,00,000

(f) Number of total fertilized eggs =

$$e \times \frac{80}{100}$$

or $\frac{100000}{100} \times 80 = 80,000$

(g) Number of total unfertilized eggs = (e − f) = g or 1,00,000 − 80,000 = 20,000 Nos

Similarly, the percentages of hatching and mortality can also be calculated by knowing the total volume of spawn lifted and the number of spawn in a known volume.

12.8 Expected Behavioural Outcome

The pupil acquires the ability to:

identify mature male and female fish for breeding,

judge the condition of brooders,

inject pituitary extract to fish brooders;

fix breeding and hatching *hapas,*

learn the breeding behaviour of fish;

examine percentage of fertilized/unfertilized eggs

hatch the eggs;

rear the spawn up to 48 hours.

The teacher should evaluate the pupil for the above abilities

12.9 Questions

(i) What procedures and what precautions are adopted for successful breeding?

(ii) How can you identify good and bad eggs in a sample?

(iii) How can you work out the percentage of good/bad eggs?

(iv) Describe in brief, breeding and hatching *hapas?*

(v) What materials are used for the inner and outer hatching *hapas,* and why?

ACTIVITY UNIT: 13

Breeding of Ornamental Fish

13.1 Instructional Objectives

The pupil should be able to.

appreciate the importance of keeping and breeding ornamental fish in an aquarium,

know the breeding habits of ornamental fish,

understand the courtship behaviour of ornamental fish;

know about the factors relevant to the breeding of ornamental fish;

arrange and place the aquarium;

maintain brood fish;

13.2 Relevant Information

What is the importance of ornamental fish?

Ornamental fish are used as decoration in houses, hotels, public parks and places of tourist interest. They also enlighten and educate school children about the behaviour of aquatic animals The aquarium hobby is becoming increasingly popular in India. It can also be taken up as a part-time business or as full time self-employment. But very few people have scientific knowledge about the maintenance and breeding of ornamental fish

Breeding habits of ornamental fish

Most varieties of the exotic aquarium fish can be bred at any time of the year if proper conditions are provided They can be divided into two main groups depending on their breeding habits.

(i) Those which lay eggs and are called egg bearers, (ii) Those which give birth to young ones and are called live bearers.

In the case of egg bearers, fertilization is external while in the case of live bearers, fertilization is internal The egg bearers can further be sub-divided into the following main groups·

(i) Those which drop non-adhesive eggs.
(ii) Those which drop adhesive eggs
(iii) Those which place their eggs in bubble nests
(iv) Those which carefully place adhesive eggs.

Sexual dimorphism in ornamental fish

The young of all species usually resemble the mother. When there is difference in colour and/or finnage, the male has the brightest colour and the largest or best developed fins. When there are no obvious differences in a group, body shape must be used as a guide The female has a rounded appearance in comparison with the slimmer male. If these fish are held with the stomach up, in a wet net, the male's stomach appears like the keel of a boat while the female's is round. In the case of live bearers, there is a contrasting dark area on the female's body, close to the vent This may be triangular or crescent-shaped and is called the gravid spot In the case of males, the anal fin becomes pointed and at maturity it lengthens into a straight rod-like projection called the gonopodium. In some species the sexes are very much alike and in such cases they can be distinguished by their behaviour — the males fight with other males but not the females.

Courtship in ornamental fish

Generally the males chase the females displaying their brighter fins, and intensifying their body colours

Selection of breeders

In the case of fully ripe breeders the colour of the body is greatly intensified. The body of the females becomes rounded and she may alternate between periods of restlessness with resting quietly in the corner with her head held lower than her tail. The males become restive and more aggressive around the tank. A day or two prior to spawning, a tube called the ovipositor develops at the vent as a very small point or nipple The apperance of this nipple is regarded as a sure sign that the fish is ripe for breeding

Maintenance of brood fish

The most important part of the maintenance is the separation of the sexes Overfeeding the breeders must be avoided, and dried food should not be given in any large quantity. The staple diet should include chopped earthworms varied with *Daphnia tubifex,* gnat larvae and other live food Fish which mate for life and also live bearers should not be separated Besides feeds, the temperature of the water, its hardness, oxygen level, pH, etc should be taken care of. Optimum temperature requirement varies from species to species But generally they breed within a temperature range of 65 to 80°F.

Number of eggs and young ones produced at a time

The number of eggs produced at a time also varies greatly from species to species and also within the same species according to age and size In the case of live bearers also, the number of brood may be as few as 3 or well over 200

Breeding aquarium

A breeding aquarium should be as large as possible — at least two feet long But the water should be filled only up to a level of 6 to 8 inches, with one end of the aquarium thickly stocked with bushy foliaged plants such as *Myriophyllum* sp and *Cabomba* sp It is better to tie these in bunches and then place them by tying them to stones They should, however, be so thick that the fish have some difficulty in making their way through them The aquarium should be situated in a warm place where it will receive the early morning sunlight The floor of the aquarium should be covered with a 2 inch thick layer of aquarium sand.

Sub Unit : Breeding of Egg Bearers

13a 1. Relevant Information

Breeding of egg-scatterers·

This group includes most of the Characins, the carps or Minnows, the egg-laying tooth carps, etc. In general the requirements for breeders of this type are similar. The aquarium should have a reasonable amount of open space but with thickets of plants having finely divided leaves such as *Myriophyllum* Many fish are more apt to spawn if they are previously separated for a few days from their males. It is usually best to place the female in the breeding tank half a day before the male. Feeding should be with live food. A partial change of water sometimes stimulates spawning or delivery Breeders should be removed after spawning Examples of egg scatterers. *Brachydanio rerio, Carrassius auratus,* Neon tetra, Rosy tetra, etc

Bubble nest builder

The fish belonging to the family *Anabantidae* have a distinguishing feature in the breeding habits, in that most of them are nest builders These nests are built by the males and are made of saliva-coated bubbles into which the fertilized eggs are placed following a courtship beneath the nest The courtship is conducted by a grand spreading of fins, first by the male with the ultimate response by the female After the nest is built, the male drives the female towards it. If she is not ready for spawning, her response will be slow and in such a situation, the male may attack her. At this time, the pair should be separated, if the situation grows worse. If the courtship has been normal, the female sheds eggs which are fertilized by the male. The female should be removed after spawning. The fry are guarded and kept within the vicinity of the nest by the male. Examples of bubble nest builders Siamese fighting-fish, Dwarf Gourami, Kissing Gourami, etc

Breeding in Cichlids

Cichlids, if left to themselves in a large group will pair up and mate by natural affinity. Courtship consists of wagging of the body, spreading of the fins and a variety of changes in colouring. Breeding methods include laying eggs on open sites, in caves, or submerged flowerpots and in some species, incubating fertilized eggs in the female's mouth This unique parental care ensures full protection to the babies from predators till the fry stage. Examples of cichlidae· Angel fish, Discus fish, etc.

13a 2. Precautions

Keep the aquarium in a warm place, where it can receive the early morning sunlight.
Do not add water to the aquarium directly from the tap.
Provide enough plants and objects such as stones, flower pots, etc., to get a substratum for the attachment of adhesive eggs.
Do not put in wild aquarium plants as they are almost certain to carry the enemies of the fry, e.g. *Hydra*
Maintain the temperature of water as per the optimum temperature requirements of the species.
Separate the partners if there is serious fighting between them.
Remove the spent fish soon after the spawning is over, otherwise they will eat their own eggs.
Do not disturb the eggs after spawning.
Remove infertile eggs carefully, otherwise they will be attacked by fungus and will spread the disease.
Feed enough live food to the brood fish.
Cover the aquarium with glass, specially in the case of bubble nest builders, to
prevent the rapid evaporation of bubbles.

13a 3. Materials Required

(i) Aquarium (at least two feet long).
(ii) Male and female breeders.

- (iii) Water stored for 24 hours
- (iv) Aquarium plants
- (v) Substrarum for attachment of eggs (aquarium plants, stones, flower pots, etc)
- (vi) Hand-nets
- (vii) Cover glass.
- (viii) Aquarium sand.
- (ix) Live food and dried food.
- (x) Thermostat.
- (xi) Thermometer.

13a 4. Procedure for bubble nest builder

Take a large aquarium at least 2 ft. long
Clean it properly.
Cover the bottom with adequate quantity of well washed aquarium sand.
Fill it with water which has been stored for at least 24 hours in order to avoid the effects of chlorine
Introduce some aquarium plants
Select the breeders.
Keep the males in a separate aquarium.
Introduce the breeders
Maintain the temperature as per the requirements of the species.
Cover the aquarium with a glass sheet
Add live food from time to time and provide aeration as and when required.
After complete spawning, insert a glass divider berween the pair in such a way that the female can be taken out.
Let the male be with the eggs in order to take care of them.
Take out the male immediately after the hatchlings/swim freely.

13a 5. Observations

The pupil should observe and record the following·

- (a) Act of building a nest made of bubbles by male fish.
- (b) Site selected for nest building.
- (c) Courtship of breeders
- (d) Temperature of water.
- (e) Spawning
- (f) Time required for spawning
- (g) Number of eggs laid by female, if possible.
- (h) Efforts taken by male fish in order to protect the fertilized eggs
- (i) Percentage of hatching

13b Sub-unit: Breeding of live bearers

13b 1. Relevant Information

The live bearer group of aquarium fish belongs to the family *Poeciliidae* There are distinct differentiating characteristic between males and females. The males are brighter in colour and have a characteristics gonopodium. The famale gives birth at approximately four weeks interval. Mating in live bearers is promiscuous. Any male will mate with any female. It is best to have extra females, as one male may pursue a single female too vigorously without giving it any rest.

Many live bearing fish are cannibalistic. Special arrangements have to be made in the aquarium to save the babies. There are two general methods of saving the young ones:

- (i) Providing them with hiding places such as plant thickets in the aquarium.
- (ii) Using some mechanical contrivance which prevents the mother from getting at the babies.

A simple method is to use a single sheet of plastic screen suspended from the long sides of the aquarium The ends must fit snugly against the short sides A special screen with openings twice as large as a flyscreen is needed Another method is the use of a V-shaped arrangement of glass sheets in the aquarium Keep the bottom of the V slightly open, for the escape of young ones.

13b 2. Precautions

Keep the aquarium in a place where it can receive the early morning sunlight

Do not add water to the aquarium directly from the tap

Introduce dense aquarium plants into the aquarium in order to provide hiding places to young ones

Do not put in wild aquarium plants as they are almost certain to contain many enemies of the fry e g *Hydra*

Maintain the temperature of water as per the optimum temperature requirement of the species

Fix either a plastic screen or V-shaped trap for preventing the young ones being eaten up by parents.

Do not handle a live bearing female just prior to her time for delivery, or it may result in premature births

13b 3. Materials Required

(i) Aquarium (at least 2 ft. long).
(ii) Water stored for 24 hours
(iii) Male and female brood fish.
(iv) Aquarium plants.
(v) Hand-nets
(vi) Cover glass
(vii) Aquarium sand
(viii) Plastic screen or 2 glass sheets
(ix) Live food and dried food
(x) Thermostat.
(xi) Thermometer

13b 4. Procedure for live bearers

Take a large aquarium at least 2 ft long

Clean it properly.

Cover the bottom with adequate, well washed aquarium sand

Fill it with water which has been stored for at least 24 hours

Introduce either aquarium plants thickly or fix a plastic screen or a V-shaped glass sheet.

Introduce the selected brooders

Maintain the temperature of water as per the requirements of the species.

Cover the aquarium with a glass sheet

Add live food from time to time and provide aeration as and when required.

13b 5. Observations

The pupil should observe and record the following·

(a) Courtship of breeders.
(b) Mating of breeders
(c) Temperature of water.
(d) Birth of young ones
(e) Time required from fertilization to delivery.
(f) Number of young ones produced.

13.3 Expected Behavioural Outcome

The pupil will be able to:
handle the brood fish carefully;
fix the diet for brood fish,
undertake breeding of aquarium fish,

The teacher should evaluate the pupil for the above abilities

13.4 Questions

(i) How will you carry out the breeding of a live bearer?

(ii) What basic knowledge should one have to undertake the breeding of ornamental fish?

(iii) Compare the breeding of an egg bearer with that of a live bearer.

ACTIVITY UNIT: 14

Hatching of Fish Eggs in Improved Type of Hatchery

14.1 Instructional Objectives

The pupil should be able to

understand the importance of hatching of fish eggs in an improved type of hatchery,

appreciate the main principle involved in an improved type of hatchery,

know the various components of the hatchery; and its fixation;

know the operational details of the hatchery system.

14.2 Relevant Information

Why operate an improved type of hatchery?

It is a common experience of the field workers that there is considerable mortality rate in hatching of eggs, when the eggs are allowed to hatch in the traditional hatching *hapa* because of temperature variations and the predatory fish Mortality to the extent of 80% is observed due to the rise of temperature on sunny days when the *hapa* is fixed in nursery tanks When *hapas* are fixed in stocking tanks or reservoirs, the fish minnows like *chela* enter the *hapa* and eat the eggs, hatchlings and then spawn These risks are eliminated in the improved type of hatchery Such a hatchery is installed with a shade where no direct sunlight enters This ensures that the temperature will not rise to lethal limits Other environmental parameters like oxygen, silt, water flow, space for movement of eggs and metabolites are under control All this results in readucing the mortality to about 20%

Components of the hatchery

Overhead tank

An overhead tank ensures automatic flow of water. A collapsible plastic pool of 750 litre capacity is arranged at a height of 3 5m to feed a 2 jar complex. The storage tank has two diaphragm type outlet valves which are connected to a pipline It is desirable to use a rigid, low density polythene pipe where installations are of permanent nature In order to maintain the optimum oxygen level, an aeration system is provided.

Hatchery Unit

The hatchery jar is conical in shape The upper part is 440 mm in diameter and the lower part is 320 mm in diameter, the height of the jar is 480 mm. The capacity, up to the outflow pipe, is 33 litres For effective use, an inner egg container is used for separating the egg shell after hatching.

Spawn receiving tank and hapa frames

This is a simple circular plastic pool of about 2 m diameter to receive water from the hatchery jars through an overflow pipe. Spawn also enters the pool along with the overflow water A *hapa* is fixed in this pool so that the spawn can be collected without difficulty.

14.3 Precautions

While purchasing the number of hatchery jars, keep in view the quantity of eggs available for hatching.

Set up the hatchery in the shade or in a cool place

Ensure that water in the overhead tank does not become hot.

Keep the water in the overhead tank as cool as possible

See that the joints and valves of the pipeline are not heavy

Ensure proper flow of water in the hatchery jar, so that the delicate eggs do not get churned violently, and, thus, damaged

14.4 Materials Required

(i) Overhead tank with valves.
(ii) Water pump for lifting water to the overhead tank.
(iii) Air compressor/blower with piping aerators.
(iv) Hatchery jar with inner egg container and overflow pipe.
(v) Plastic pool with *hapa* for retaining spawn
(vi) Eggs of Indian major carps.

14.5 Procedure

Check whether there is sufficient cool water in the overhead tank (20°C to 30°C).

Ensure that water has sufficient (8-10 ppm) dissolved oxygen. Otherwise, aerate the water for one hour before use.

Check circulation of water in the hatchery jars and outflow.

Maintain a flow of 2-4 litres/minute.

Gently pour a mug of fertilized and water hardened eggs in the egg container (placed in the hatchery jar) up to half the capacity of the egg container

Continue the cirulation of water in the hatchery jar

Check periodically to regulate the flow of water so that the eggs do not get damaged due to strong current

Continue to watch development of eggs (eggs hatch in 15 to 18 hours at 26 - 31°C)

Hatchlings ordinarily remain in the hatchery jar outside the egg container Some may escape in the spawn receiving container

Watch the growth of hatchling into spawn (on the fourth day, spawn which is free swimming and without yolk-sac is formed)

Make arrangements for despatch of spawn to the nursery unit for further growth.

14.6 Observations

(a) Count the number of eggs before pouring them in the hatchery jar (if possible ascertain the % of fertilized eggs).
(b) Estimate the number of fertilized eggs.
(c) Record the time required for hatching of eggs to hatchlings.
(d) Record the time required for developing hatchlings into spawn

Observations may be recorded in the Table given below:

Batch No. (1)	*No. of eggs received* (2)	*No. of fertilized eggs* (3)	*No. of hatchlings* (4)	*Time taken to form hatchlings* (5)

Time taken for developing hatchlings into free swimming spawn (6)	*Total spawn obtained* (7)	*% of survival* (8)	*Spl Remarks if any* (9)

14.7 Expected Behavioural Outcome

The pupil will be able to:

understand the importance of hatching of fish eggs in an improved type of hatchery;

know the operation of an improved type of hatchery;

understand the reasons for the unsuccessful hatching of eggs.

The teacher should evaluate the pupil for the above abilities.

14.8 Questions

(i) What is the importance of hatching of fish eggs in an improved type of hatchery?

(ii) What will happen if the flow of water is not properly regulated?

(iii) What are the advantages of an improved type of hatchery as compared to the traditional method of using a hatching *hapa?*

(iv) Describe in detail the various components of an improved type of hatchery.

(v) Describe in detail the operation of an improved type of hatchery.

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